# RESEARCH PLAN PROPOSAL

**Design and implementation of prediction model to examine the impact of variability over external quality attributes in context of software product line variability models**

For registration to the degree of

Doctor of Philosophy

**IIS (deemed-to-be)UNIVERSITY, JAIPUR**

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## 1. Topic

Design and implementation of prediction model to examine the impact of variability over external quality attributes in context of software product line variability models

## 2. Introduction

### 2.1Quality Attributes

Bevan (2015) defines quality as: “The totality of characteristics of an entity that bear on its ability to satisfy stated and implied needs”. The quality model presented in ISO/IEC 9126-1, has categorized software quality into a structured set of characteristics and sub-characteristics. Every sub characteristic is further classified into attributes. The software community has been interested in quality attributes since 1970s. There is a wide range of taxonomies including definitions focusing on quality. A quality attribute can be defined as a property of a system which can be measured or tested and is useful in identifying how well the system is satisfying the requirements of its stake holders. Attributes can be thought of as entities which can be measured or even verified in the software product.

### 2.2 Software Product Line

As defined by Clements and Northrop (2002) Software Product Line is:
“A set of software-intensive systems that share a common, managed set of features satisfyingthe specific needs of a particular market segment”.
A software product line, or software product line development, includes software engineering methods, tools and techniques for creating a collection of similar software systems from a shared set of software assets using a common means of production. It focuses on systematic reuse instead of ad hoc reuse. This reuse is achieved in the case when applications share features or characteristics.
Software product line is gaining popularity because it aims at the specification, construction, management and maintenance of complex software systems with the goal of reuse, variability, and efficiency. The following benefits can be gained by software product line:

- Reduced time-to-market and time-to-revenue for new products
- Improved competitive product value
- Higher profit margins
- Improved ability to hit market windows
- Better product quality and improved company reputation for quality

- Improved scalability of business model in terms of products and markets
- Increased agility to expand into new markets
- Reduced risk in product deployments

## 2.3Feature Model

Feature model is a compact representation of all the products of the Software Product Line (SPL) in terms of "features". Feature models are visually represented by means of feature diagrams. Feature models are widely used during the whole product line development process and are commonly used as input to produce other assets such as documents, architecture definition, or pieces of code.Feature models were first introduced in the Feature-Oriented Domain Analysis (FODA) method by Kang in 1990.

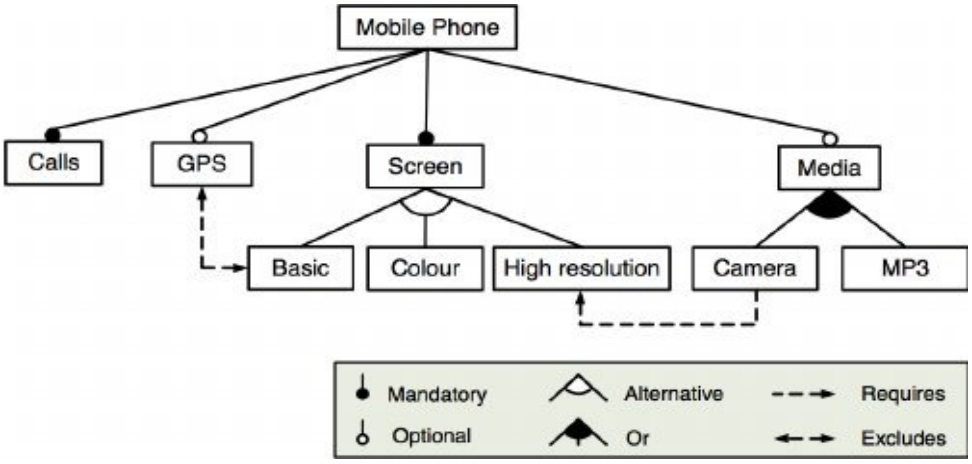



Figure 1 Sample Feature Model of Mobile Phone

A basic feature model is a hierarchically arranged set of features, where each parent-child relation between them is one of the following types (each having a suitable graphical notation as shown in Fig. 1 and in Table I): • Or – at least one of the sub-features must be selected if the parent is selected. • Alternative (Xor) – exactly one of the sub-features must be selected whenever the parent feature is selected. And – if the relation between a feature and its sub-features is neither an Or nor an Alternative, it is called And . Each child of an And must be either: – Mandatory – child feature is required, i.e., it is selected whenever its respective parent feature is selected. – Optional – child feature is optional, i.e. it may or may not be selected if its parent feature is selected.

- Mandatory- features must be included in the description of the parent feature.

- Alternative feature group- one and only one feature from the group can be included in the description of the parent.
- Optional- the feature may or may not be included in the description of the parent.
- Or feature group- one or more features from a feature group can be included in the description of the parent.
- Excluded- the presence of the feature requires elimination of another feature or set of features.
- Includes- the presence of given feature requires the existence of another feature or set of features.

## 2.4Variability Management

Managing differences between products of a product line is one of the essential matters that must be considered when building a product line. This activity is called variability management. Effective variability management requires comprehensive changes to the software development process. The focus must be changed from mere commonality management to include also variability management. Variability must be considered at each development phase from the requirements collection to the final implementation. Even duringmaintenance and development of new product versions, variability must be handled. We begin the exploration of this subject by considering basic concepts concerning variability management and especially we describe how variability in requirements can be identified and documented.

## 2.5 Maintainability & Reusability

Maintainability is the ease with which a software system or component can be modified to correct faults, improve performance, or other attributes, or adapt to a changing environment. the three main sub characteristics of maintainability: analyzability, changeability, and understand ability.

## 3. Review of Literature

### Table-1 Literature reviewed to study about Variability Management

| S.no | Year | Author | Publication | Title | Work done | Lacks |
|---|---|---|---|---|---|---|
| 1 | 2017 | SumayaIbraheem and Said Ghoul | Journal of Software Engineering | Software Evolution: A Features Variability Modeling Approach | This paper present software feature-based evolution variability modelling technique of a new methodology producing an extended feature model by new meta features and relations. | Author not proposed the feature-based variability modelling and quality attributes in context of spl. |
| 2 | 2016 | David Wille,Sandro Schulze | ACM | Variability Mining of State Charts | In this paper, a feature-based variability approach for had extended the traditional feature model concepts with evolution ones by building an extended feature model from the traditional one. | Author not proposed the approaches for feature model. |
| 3 | 2016 | AzadehAlebrahim, Stephan Faßbender | ACM | Variability for Qualities in Software Architecture | Author focus on software architecture since it directly influences the fulfillment of a software system's quality attributes. | Author not proposed the early design decision ,reduce complexity in spl and Unforeseeable Variability approaches. |
| 4 | 2014 | Thorsten Berger,JianmeiGuo | ACM | Towards System Analysis with Variability Model Metrics | This paper Introduced a set of low-level variability model metrics implemented them in a tool conducted a correlation analysis among these metrics; and explored their relationship to code metrics in real-world systems. | Author not proposed Evaluation of applicability of metrics to feature model and further realistic models. |

## Table-2 Literature reviewed to study about Quality Attributes

| S.no | Year | Author | Publication | Title | Work done | Lacks |
|---|---|---|---|---|---|---|
| **1** | 2018 | JihenMaazoun, Nadia Bouassida 1 | Springer International Publishing AG | Evaluating SPL Quality with Metrics | Research done to evaluate quality an SPL at three level feature model, Design and code. | Core focus on feature model design and code not quality attributes. |
| 2 | **2017** | Satinderjit KaurGill, Dr.Amita Shrama | International Journals of Advanced Research in Computer Science and Software Engineering | Evaluating the Importance of Analyzability, Testability and Changeability Quality Attribute in Reference to Software ProductLine Orthogonal Variability Model | This paper is based on assessment of maintainability on OVM model in software product line. | OVM is related to only different features it does not support common features |
| **3** | 2016 | Carla I. M. Bezerra,José Maria Monteiro, Rossana M. C. Andrade | ACM | Analyzing the Feature Models Maintainability over their Evolution Process: An Exploratory Study | This paper presents an exploratory study on the impact of feature models maintainability over the SPL evolution process. built a dataset containing a compiled set of 21 maintainability structural measures extracted from 16 feature models and respective versions. | Author not investigate how use the metric suite to improve the feature model maintainability in realistic model. |
| **4** | 2017 | MateusPassosSoares Cardoso | ACM | Investigating the Variability Impact on the Recovery of Software Product Line | This paper presents an exploratory study that investigated the effectiveness of recovered PLAs to address variability identification and support reuse assessment | Author main focus is to optimize there covered PLA to address other types of variability not mapped. |

## Review of Literature

1. Ibraheem S[2017] This paper present software feature-based evolution variability modelling technique of a new methodology producing an extended feature model by new meta features and relations. The obtained results compared to the actual approaches seem to be promising. The bio-inspired software evolution has led to identify weaknesses of currents feature-based evolution approaches. The introduction of new powerful feature modelling concepts and supporting formal approach, inspired from nature is expected to promote the software evolution.
2. WilleD[2016] In this paper, a feature-based variability approach for had extended the traditional feature model concepts with evolution ones by building an extended feature model from the traditional one. state charts allow companies to save money when developing individual software systems, creating software families consisting of multiple variants is still a time consuming and complex task.
3. AlebrahimA[2016], Author focus on software architecture since it directly influences the fulfillment of a software system's quality attributes. software product lines many software systems are designed to support variability, either at design time (for example, as product lines or product families) or at runtime, especially for self-adapting or service-based systems. Variability itself comes in two dimensions: functional variability and variability in software qualities. There is an obvious imbalance between the importance of variability in the context of quality attributes and the intensity of research in this area.
4. Berger T[2014] author discussed perspectives of variability model metrics (P1-P5), introduced a set of low-level variability model metrics implemented them in a tool conducted a correlation analysis among these metrics and explored their relationship to code metrics in real-world systems. author measure structural properties, comprising core characteristics of models. Author present GQM strategy approach to developing metrics.
5. Maazoun J[2018] In this paper author propose a set of metrics to evaluate the quality of an SPL at three levels: the feature model, design and code adapted a set of metrics for software quality and defined new metrics to deal with the inherent characteristics of SPLs, specifically the feature model and the traceability between features, design and code.
6. Gill S[2017] author described assessment of maintainability on orthogonal variability models in software product line. Author take three important sub characteristics of Maintainability and study the role of analysability, testability and changeability quality attributes over Orthogonal Variability Models.
7. BezerraC[2016] This paper presents an exploratory study on the impact of feature models maintainability over the SPL evolution process. built a dataset containing a compiled set of 21 maintainability measures extracted from 16 feature models and their different versions to support author analysis identified a set of changes that are recurring in the feature models evolution.

8. Cardoso M[2017] author discussed exploratory study that investigated the effectiveness of recovered PLAs to address variability identification and support reuse assessment.Software Architecture Recovery(SAR) approaches share the goal of documenting software architecture and provide solutions to problems such as the absence of documented software architecture, and the need for detecting violations between conceptual and implemented architectures.

## 4.Motivation

In today's world, variability assessment has become a key factor for the technological transformation towards achieving the business goals through its extensive list of advantages. Literature review shows that there is lack of generalized variability models over external quality attributes in context of software product lines. there has been a very limited research work in this field, due to the uncertainty related to the data none of them presented the area of the impact of variability of variability models over external quality attributes in context of software product lines .
Usability (reusability) and maintainability are strong pillars of software product line feature model but unfortunately these important factors are left untouched. The aim of this research is to study quality attributes of variability model's in software product line and propose new metrics for assessing quality attributes generalized metrics for measuring the impact of variability over other quality attribute . These measures will help us to analyze the effect of quality attributes applied to a product line with respect to enhancing external quality attributes by handling variability of variability model(s) gives motivation towards research in this direction.

## 5.Objectives

The major objectives:

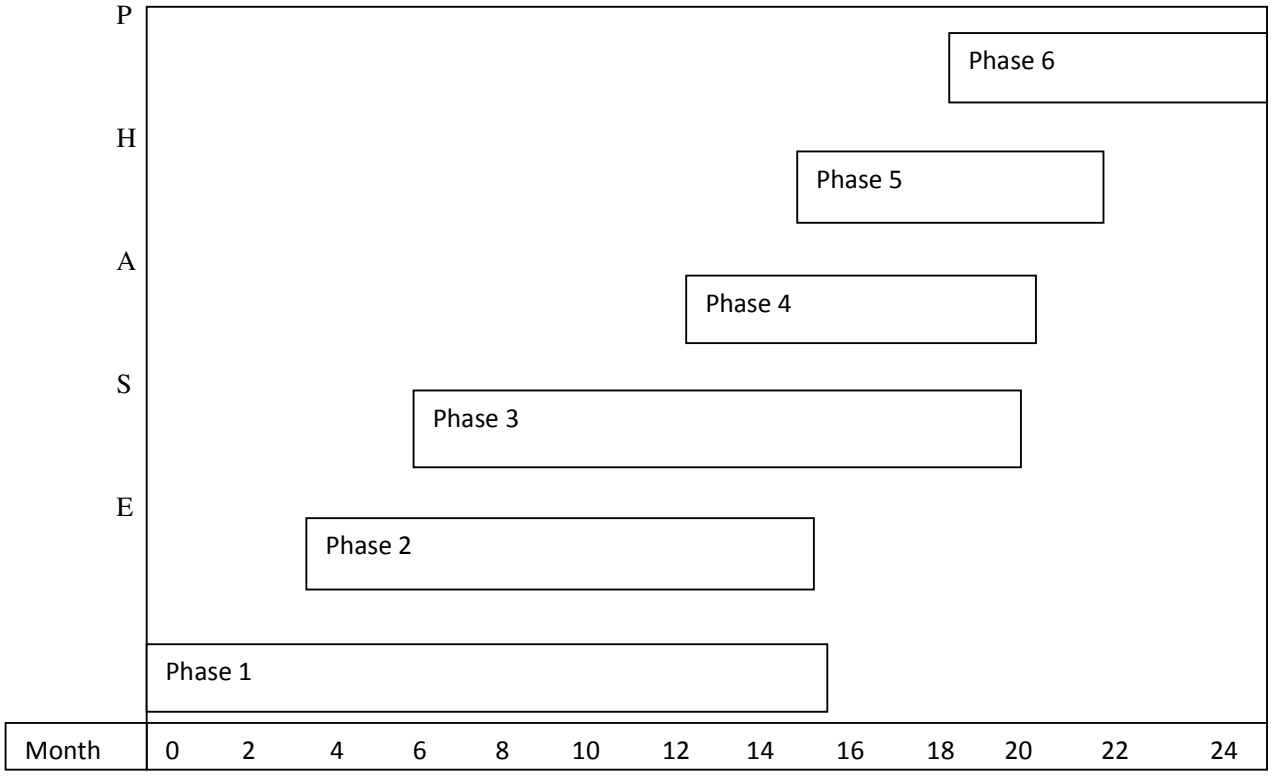
1. To study various quality attributes, variability models and metrics for assessing quality attributes in reference to SPL.
2. To propose improvement / new metrics for assessing quality attributes.
3. To assess variability and other quality attribute(s) by applying metrics over variability model(s) and analyze the results.
4. Analyze the impact of variability over other quality attribute(s).
5. To develop tool for enhancing external quality attributes by handling variability of variability model(s).

## 6. Plan of work and methodology

### 6.1Work Plan:

| Phase No. | Phase description | Approximate time duration (in months) |
|---|---|---|
| 1 | study various quality attributes and variability models | 3-7 |
| 2 | study various metrics | 2-8 |
| 3 | propose improvement / new metrics for assessing quality attributes | 4-8 |
| 4 | assess variability and other quality attribute(s) by applying metrics over variability model(s) | 4-8 |
| 5 | study the impact of variability over other quality attribute(s) | 6-9 |
| 6 | develop tool for enhancing external quality attributes | 5-6 |

### 6.2 Gantt chart:



## 6.3Methodology

1. Review various quality attributes and variability models like feature model, Orthogonal variability Model, Unified modeling Language.
2. Study various metrics
3. Propose improvement / new metrics for assessing quality attributes
4. Assess variability and other quality attribute(s) by applying metrics over variability model(s)
5. Analyze the impact of variability over other quality attribute(s)
6. Develop tool for enhancing external quality attribute(s)

## 6.4Work Flow

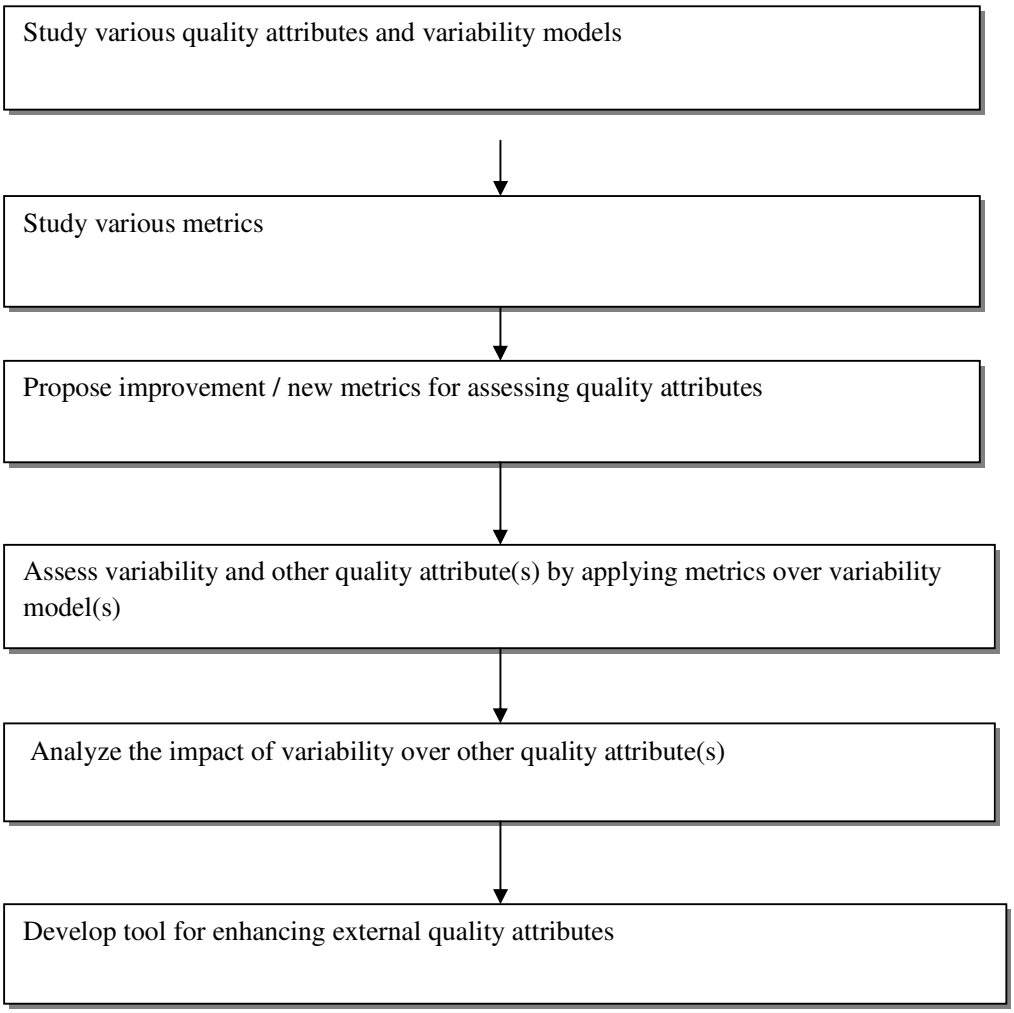

Study various quality attributes and variability models
Study various metrics
Propose improvement / new metrics for assessing quality attributes
Assess variability and other quality attribute(s) by applying metrics over variability model(s)
Analyze the impact of variability over other quality attribute(s)
Develop tool for enhancing external quality attributes

Figure -2 Work Flow

## 7.References


1. IbraheemS. and S. Ghoul (2017) Software Evolution: A Features Variability Modeling Approach, *Journal of Software Engineering,***Volume 11(1),** (12-21).
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5. Maazoun,J.,N.Bouassida and H. Ben-Abdallah (2018) Evaluating SPL Quality with Metrics,
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8. CardosoM.,LimaCandAlmeidaE(2017),InvestigatingtheVariabilityImpacton the Recovery of Software Product Line Architectures: An Exploratory Study ,*SBCARS '17 Proceedings of the 11th Brazilian Symposium on Software Components, Architectures,* and *Reuse,* Article No. 12.
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